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IDA MEMORANDUM REPORT M-376

## Ada VALIDATION WORKLOAD

Audrey A. Hook  
R. Danford Lehman

January 1988



*Prepared for*  
Ada Joint Program Office

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Audrey A. Hook  
R. Danford Lehman

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## **PREFACE**

This work partially fulfills requirements of IDA Task T-D5-304, Ada Validation, for support to the Ada Joint Program Office through analysis of technical or management issues within the Ada compiler validation process.

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## 1.0 PURPOSE

The purpose of IDA Memorandum Report M-376, *Ada Validation Workload*, is to provide the Ada Joint Program Office (AJPO) with an analysis of the validation workload for Ada compilers and the problems surrounding the annual expiration of an ACVC version. This report is intended for those individuals in the AJPO who develop the policy and procedures that govern the validation process.

## 2.0 SCOPE

This paper focuses on the Ada Validation Facilities (AVFs) workload associated with validations under Ada Compiler Validation Capability (ACVC) version 1.8. A projection of workload growth has been excluded from this analysis. Section 3 presents the background and data supporting the assertion that there is a serious imbalance in the Ada Validation Facility workload. Section 4 discusses findings concerning this imbalance and Section 5 provides recommendations for changes to the Validation Procedures and Guidelines and to the AVF workforce that will improve the management of that workload

## 3.0 BACKGROUND

Issuance of the AJPO Validation Procedures and Guidelines (Version 1.1) indicates that the process of validating Ada compilers has become a relatively stable set of procedures. These procedures have undergone continual refinements since the inception of validation. However, as much as usage and analysis have identified and eliminated past problems with the process, one long-standing problem remains. This problem is the concentration of most of the validation work in the three months surrounding the annual expiration of the ACVC version on 31 May. The second calendar quarter (April, May, and June) constitutes a critical period of intense demand on the resources of the Certification Body. This concentration of demand strains the process's human resources and aggravates its incident problems.



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The demand for validation and re-validation services has increased significantly with each ACVC version since version 1.6. The total number of validations completed during the life of each ACVC version is shown in Figure 1. Even though the number of AVFs has also increased from one to five, the greatest demand for validation and revalidation services is not evenly distributable among these five AVFs.

**Figure 1 Validations Per ACVC Version**

1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
3	0	3	8	7	22	41	122

Of the 122 validations completed using ACVC 1.8, about two thirds of the validations were conducted after 1 April by three AVFs. Nearly three quarters of all the validation work was done from March through June (see Figure 2).

**Figure 2 Validation Demand for ACVC 1.8**

<b>Wright-Patterson AFB, USA.</b>						
<b>IABG, Fed. Rep. of Germany</b>						
<b>BNI/AFNOR, France</b>						
<b>GSA/NBS, U.S.A.</b>						
<b>NCC, U.K.</b>						
JUN	0	0	0	0	0	0
JUL	0	0	0	0	0	0
AUG	1	0	0	0	0	1 (3-month subtotal)
SEP	0	0	0	1	1	2
OCT	0	0	0	0	3	3
NOV	0	1	0	0	2	3 8
DEC	4	0	5	0	4	13
JAN	0	0	0	0	2	2
FEB	0	2	0	2	4	8 23
MAR	0	0	0	2	7	9
APR	2	2	0	0	6	10
MAY	3	2	2	1	9	17 36
JUN	13	10*	0	0	31	54* 54 (* 1 JUL test included)
<b>Totals:</b>	<b>23</b>	<b>17</b>	<b>7</b>	<b>6</b>	<b>69</b>	<b>122</b>

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Why is there a critical period of heavy validation demand surrounding the expiration of an ACVC version? What can be done to re-distribute or manage this demand? This document addresses these questions, analyzes the surrounding issues, and proposes several solutions.

### 4.0 FINDINGS, DISCUSSIONS AND CONCLUSIONS

In Section 4.0, we present the findings, discussion, and conclusions concerning the factors that contribute to the critical demand period, the probable limit on human resources that can be available during this period, and procedural changes that might motivate vendors to schedule validation earlier in an ACVC version life. Pertinent pages from the *Ada Validation Procedures and Guidelines* have been included in Appendix A.

#### 4.1 VENDOR BEHAVIOR

##### 4.1.1 Finding

During ACVC 1.8, vendor behavior indicates that there is a tendency to validate or re-validate as late as possible in the ACVC version life. Sections 4.1 and 4.2 are being interpreted as official permission to complete validation with an expired ACVC version if vendors can show the AVF that they have used that version for pre-validation testing before it expired (31 May). (See Appendix A for the specific parts of Sections 4.1 and 4.2 that address scheduling, use of an expired ACVC, and automatic extension of certificates.)

##### 4.1.2 Discussion

The Procedures and Guidelines Section 4.1 is being interpreted to mean that a compiler vendor may be permitted to validate a compiler using an expired version of the ACVC if the vendor has submitted pre-validation materials to the AVF before 1 June. This interpretation ignores the requirement that "the AVF has had sufficient time to determine that there are no failures."<sup>1</sup> AVF experience indicates that, on the average, at least two

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<sup>1</sup> Ada Compiler Validation Procedures and Guidelines, Version 1.1, 1 January 1987, p. 10, Section 4.1.4.

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weeks should be allowed for analysis, resolution of issues, and preparation of the draft validation summary report (VSR) for Ada Joint Program Office/Ada Validation Organization (AJPO/AVO) review and comment. The number of validations completed after 31 May (with an expired test suite) indicates that several AVFs imposed the 31 May deadline for submission of pre-validation materials but performed analysis of these materials later.

Section 4.2 requires that a vendor submit a compiler for revalidation in a timely manner (as defined in Section 4.1, Step 4, page 10), in order to qualify for automatic extension of the validation certificate (VC). Thus the Procedures and Guidelines require that the vendor give consideration to the time estimates given in Section 4.1 for completing the validation process, including issuing a certificate. However, some vendors wishing to re-validate have not reflected this consideration of the time required to analyze pre-validation materials and to complete the subsequent steps leading to a certificate.

Of the 43 re-validations under ACVC 1.8, 18 were done after the expiration of the VC. Of the 24 revalidations that took place one month or more prior to the expiration of a VC, 9 of these were early re-validation under ACVC version 1.8 rather than version 1.9 with its increased coverage. Another 5 revalidations were performed just prior to the end of the 3-month extension period that all 1.6 VCs received. Only 10 of these 24 revalidations were performed significantly in advance of the compiler's VC.

In the pre-April period, the validation workload was evenly divided between new validations and revalidations. In the critical period, revalidations numbered about the same as before; however, the bulk of the demand during the last quarter was for testing compilers that had not been validated before. When vendors encountered development problems, it was necessary to re-schedule validation even later. There was some indication that even experienced vendors planned first-time validations as late as possible.

### 4.1.3 Conclusions

- The Procedures and Guidelines document is being interpreted in a way that permits informal extensions of the 12-month ACVC version life.
- The vendor demand pattern evident during ACVC 1.8 (and 1.7) will persist in subsequent ACVC cycles. Since there is no incentive for early validation and

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re-validation, testing under ACVC 1.9 will be concentrated in the last quarter and continue through July, or later.

### 4.2 ALTERNATIVE PRACTICES

#### 4.2.1 Finding

The AJPO should consider feasible approaches for reducing vendor tendencies to schedule late and for reducing peak AVF workloads caused by the expiration of an ACVC version.

#### 4.2.2 Discussion

We have found that three approaches are feasible. They are:

- extending certificate life;
- providing for late validation; and,
- fixing certificate expiration dates.

##### 4.2.2.1 Extended Certificate Life

The extended certificate life approach attempts to use exhibited vendor behavior to more evenly distribute the demand for services. Since new vendors can be expected to validate as late as possible in the ACVC version life, we can leave this period open for new vendors by issuing a certificate that expires later than 12 months from the date of issue (e.g., 16 months). The central idea is to issue a certificate that has a longer life than the ACVC version so that certificates issued at one point in the ACVC version cycle will expire at a different point. Although the present year's large number of critical-period validations would still present a concentrated demand for revalidation, this demand would come at a different point in the ACVC cycle from the expected heavy demand for new validations. The peaks in demand for re-validation may begin to even out as some vendors rely on automatic extensions of their certificates to do re-validations at a later date. However, the concentration of re-validation workload is not likely to be significantly dispersed throughout the year.

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### **4.2.2.2 Limited Provision for Late Validation**

This alternative provides conditions for using an ACVC test suite version after its expiration date. It is intended to remove a particular date from being the focus of last-minute validation efforts by allowing additional time for vendors to complete their implementation while imposing a reduction in the life of the validation certificate that can be received as a result of using an expired versions of the ACVC for validation.

In this alternative, disputed tests must be submitted by the vendor before expiration of the ACVC version that will be used for validation. Pre-validation materials may be submitted to the AVF after the expiration date of the ACVC version, but these materials must reflect the AVO resolution of any disputed tests. On-site testing should begin within a month following submission of the pre-validation materials. If on-site testing completes successfully, the vendor will be awarded a validation certificate with an expiration date that is equal to the test suite version's expiration date plus one year. It is expected that this provision for late validation will not be used repeatedly by a vendor. The AVF can discourage vendors from habitual late validation through contract negotiations.

The certification body (AJPO, AVO, AVFs) may define other conditions to be met in order to qualify for late validation. For example, it may be desirable to establish a cut-off date for submission of a letter of intent, or for submission of pre-validation materials, or for completing on-site testing. These deadlines may be desirable so that an AVF can arrange to preserve its capability to use the expired ACVC without impact on validations with the current ACVC. The late validation alternative is limited by the requirement for submission of disputed tests before the ACVC version expires and may include other deadlines that can be imposed by the certification body.

### **4.2.2.3 Fixed 12-Month Certificate**

The fixed 12-month certificate approach addresses the vendor tendency to schedule validation near or after the expiration date of an existing certificate. With this alternative, the expiration date of a certificate is always 12 months from the expiration date of the previous certificate (rather than 12 months from the date of issue as is the current practice). Vendors who validate earlier than the expiration date do not lose some period of validated status under a current certificate. Vendors who wait to schedule until just before or after a certificate expiration date do not gain the additional time granted by an automatic extension because the new certificate expiration date will be fixed at 12 months from the expiration

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date of the old certificate. Thus vendors with current validation certificates would be less motivated to schedule later and might start validation earlier. This motivation can be reinforced by requiring the vendor to schedule or begin on-site testing prior to the expiration of the current certificate in order to qualify for an automatic extension.

### **4.2.3 Conclusions**

The Extended Certificate Life alternative will help segregate workloads for re-validations from validation of new implementations, but does not directly address vendor tendency to schedule late in an ACVC version life or after expiration of a VC. Limited Provision for Late Validation and the Fixed 12-month Certificate alternatives, taken together, provide motivation for vendors to cooperate with AVFs in managing workload schedules. Thus vendor motivation is in the form of disincentives for delays in scheduling and completing validation.

## **4.3 AVF WORKLOAD**

### **4.3.1 Finding**

The three AVFs with the heaviest workloads are those that have, or soon will have contracts in place, for validation services of Ada compilers. Only one of these AVFs can augment the workforce during the critical period.

### **4.3.2 Discussion**

Contractor support for validation services is intended to provide personnel who are skilled in analytical and on-site testing procedures for one or more programming languages. These contracts provide an AVF with a labor pool but there is some limit as to the numbers of people with experience in Ada validation who can be available during the peak workload period for Ada validation. Figure 3 is an estimate of the number of contractor personnel that can be used by AVFs to perform technical tasks associated with Ada compiler validation.

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**Figure 3 Estimate of Contractor Personnel**

AVF	No. of Contractors
Wright-Patterson Air Force Base	16
National Bureau of Standards (NBS)	6 (projected)
Ministry of Defense, UK	<u>8 (projected)</u>
	30

Wright-Patterson uses these contractor personnel in teams consisting of two people per validation projects with each team is capable of completing one project per month. At NBS and in the UK, teams are generally not used. The analyst hours per validation project can vary from 150 to 350 hours; however, on the average, the output for NBS and the UK is one validation project per person-month (14 per month). Thus the combined validation service capacity for these three AVFs is about 22 validation projects per month. Wright-Patterson is the only AVF that can increase the number of available teams if there is adequate lead-time to locate or train analysts. However, this expansion of resources has some limit, as yet undefined, in terms of available funds and human resources.

The demand for last quarter validation under ACVC 1.8 at these three AVFs was 82 validations. Even though this number includes several validations that were completed within a single project (requiring only one on-site visit by the AVF), the demand for ACVC 1.9 validations and re-validations will likely exceed the supply of AVF resources as new customers are added to the demand pattern. The extra workforce that Wright-Patterson may be able to obtain during the critical period will be a crucial factor in being able to accommodate the workload for ACVC 1.9. The establishment of an additional AVF in the U.S., with a contract modeled on the current Wright-Patterson contracting vehicle, would provide more flexibility not only for peak workload periods but also for meeting an overall increase in workload.

### 4.3.3 Conclusion

The capability of the AVFs in the US and in the UK to accommodate an expanding workload for Ada validation services is limited. Concentration of demand during the critical period in 1988 will expose these limitations.

## 5.0 RECOMMENDATIONS

### 5.1 LIMITED PROVISION FOR LATE VALIDATION

Permit a limited use of an expired ACVC version by incorporating a Limited Provision for Late Validation in the wording of the Ada Validation Procedures and Guidelines, paragraph 4.1. The following revised wording is proposed: (the new wording has been italicized.)

Paragraph 4.1 STEPS AND PROCEDURES. There are nine steps in *the* Ada VALIDATION *process* that a VENDOR and the CERTIFICATION BODY must successfully complete. *It is expected that the first seven of these steps will be completed prior to the expiration of the ACVC version that is used in VALIDATION testing.* These steps are:

Paragraphs 4.1.1 through 4.1.3 - no change.

Paragraphs 4.1.4 - Last paragraph within 4.1.4 (ref. page 10, Ada Validation Procedures and Guidelines).

*In the event that a VENDOR completes step three in the VALIDATION process (i.e., Negotiate a formal agreement and submit disputed ACVC tests) prior to the expiration date of the current ACVC, and that the expiration date is subsequently reached before the VALIDATION process is complete, then the VENDOR is allowed to proceed with the original ACVC provided that:*

- a. The AVF determines that there are no failures of APPLICABLE ACVC TESTS, and*
- b. the VENDOR does not submit test disputes after the expiration of the ACVC version that will be used for validation, and*
- c. the AVF agrees to complete the VALIDATION process after giving consideration to already scheduled work.*



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*Completing the VALIDATION after the expiration of an ACVC version is a late VALIDATION. It is intended that there will be a limited use of the provision for late VALIDATION by VENDORS. The AVF may impose additional conditions that must be met by the VENDOR to ensure that a VENDOR does not habitually rely on late VALIDATION.*

### 5.2 FIXED 12-MONTH CERTIFICATE

Provide explicit qualifying conditions for an automatic extension of a VALIDATION CERTIFICATE by incorporating a Fixed 12-Month Certificate in the wording of Section 4.2. The following wording is offered for consideration. Changes to the current wording have been italicized.

Paragraph 4.2 CERTIFICATE EXPIRATION. VALIDATION CERTIFICATES expire in accordance with the time period established by the Director, AJPO. This time period is currently one year after the date of issue *when the VENDOR has completed step 7 of the VALIDATION process prior to expiration of the ACVC version used for VALIDATION. Subsequent VALIDATION CERTIFICATES issued for this BASE COMPILER will have an expiration date that is fixed at one time period beyond that of the previous VALIDATION CERTIFICATE when the VENDOR has completed step 7 of the VALIDATION process prior to the expiration date of the ACVC version used for VALIDATION. When a VENDOR has completed step 7 of the VALIDATION process after the expiration date of the ACVC version used for VALIDATION, the expiration date of the VALIDATION CERTIFICATE will be one time period beyond the expiration date of the ACVC.*

*A BASE COMPILER and associated DERIVED COMPILERS will be removed from the list of VALIDATED Ada COMPILERS when the VALIDATION CERTIFICATE for the BASE COMPILER expires. The VENDOR may request that the AJPO not remove the BASE COMPILER and associated DERIVED COMPILERS from the list of VALIDATED Ada COMPILERS when the VENDOR has:*

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- a. *begun step 7 of the VALIDATION process prior to the expiration date of the VALIDATION CERTIFICATE for the BASE COMPILER, or*
- b. *requested an AVF to schedule step 7 prior to the expiration date of the VALIDATION CERTIFICATE for the BASE COMPILER but has been delayed because the AVF had prior commitments for VALIDATION.*

*It is the intent of the CERTIFICATION BODY that VENDORS schedule the REVALIDATION of their VALIDATED COMPILERS to occur in advance of the expiration of the associated VALIDATION CERTIFICATE. By applying a rule for establishing the expiration date at a fixed time period that is relative to the previous expiration date, a VALIDATION CERTIFICATE extends the time that an Ada COMPILER is a VALIDATED COMPILER by a fixed amount, regardless of when the actual testing occurs. Thus, all VENDORS may complete step 7 well before the expiration date of a VALIDATION CERTIFICATE without concern for redundant coverage."*

### 5.3 AVF WORKLOAD

A decision to establish an additional AVF should be based upon analysis of the workload for ACVC 1.9. This analysis should also include the geographic distribution of clients and criteria for selecting an organizational entity that will be chartered as an AVF.

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